CONSTRUCTION AND STANDARDIZATION OF A BATTERY OF BRAILLE SKILL TESTS

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COLORADO BRAILLE BATTERY
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FOREWORD

The American Printing House for the Blind has made a recent decision to publish the Colorado Braille Battery. The entire battery has been made available to the field with the exception of one of the two alternate forms of the Nemeth Tests. Only one form of these tests is being made available since the recent revision of the Nemeth Code will soon make the existing Nemeth Tests obsolete. It is anticipated that tests of the revised code will be added to the battery after the braille reading population becomes familiar with the revised code.

With the decision of APHB to publish the Colorado Braille Battery, it has become desirable to make the technical background of the battery more accessible to users. The development and standardization of the Colorado Braille Battery was originally described in the final report of Cooperative Research Project No. 1650 prepared in 1964. This report was disseminated through the U. S. Office of Education and is available in any library which participates in the Library of Congress Documents Expediting Project.

Technical Report No. 1 is the substance of the final report for Cooperative Research Project No. 1650. The entire report has been completely reproduced with the exception of Appendix C which contains copies of the manuals for the Literary Code Tests and for the Nemeth Code Tests. Users of the Colorado Braille Battery can obtain these manuals from APHB. Other Technical Reports will be prepared as additional data accumulates with the use of the Colorado Braille Battery in the field. The senior author would appreciate receiving suggestions for improving the battery and reports of research utilizing the tests.

In conclusion, these too few words of acknowledgement are in order. A project such as this has involved hundreds of people who cannot be listed by name but whose contributions of time and advice made possible the publication of a battery of braille tests. Fully a third of the people concerned with educating the blind in the United States were involved in this project in some way at some time. Many of these people will be able to see the direct results of their contributions in the tests and manuals. Others will see their contributions in the form of data accumulated from the administration of thousands of tests during the standardization of the battery. Acknowledgement by name is made in the text and in Appendix A to the schools which participated in various phases of test development and standardization. The cooperation of these schools and their staffs is greatly appreciated. Mrs. Opal F. Sparks, presently with the Jefferson County School System in Colorado, and Mr. Donald Pickering, now Principal of the Iowa Braille and Sight Saving School, assumed major responsibilities in the development and standardization of the battery in their role as Research Assistants on the project.

A special note of thanks is due Miss Marjorie Hooper and her staff at APHB. Their advice and cooperation was of inestimatable value. During the spring of 1963 APHB prepared and published the Standardization Edition of the battery and distributed it to the 62 schools participating in the standardization.

The decision of APHB to publish the 1966 edition of the Colorado Braille Battery makes available to the field a set of tests which allow objective measurement of knowledge of the braille codes. The tests should find use with blind children and adults, sighted persons required to have a knowledge of the braille codes, and as a research tool.

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Cooperative Research Project No. 1650

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CHAPTER I

PROBLEM AND OBJECTIVE OF THE STUDY

The evaluation of any type of educational achievement is generally facilitated by the use of standardized tests which measure the acquisition of skills or mastery of content. Measures of educational achievement are as greatly needed for the blind as for the seeing. As the quality and sophistication of measuring instruments for the blind develop, so will the potential for more effectively evaluating and planning their educational program.

The repertory of achievement tests for use with the blind is limited. Most available tests are braille transcriptions of widely used print tests. Normative and reliability data, based upon the performance of blind subjects, are not generally available for these tests in their braille form. Standardized tests designed to measure knowledge of the braille codes are virtually non-existent, although the use of these codes requires the blind learner to acquire a body of knowledge which is unique and additional to that learned by his seeing counterpart.

Several factors underlie the limited development of braille tests. The primary factor is simply a matter of demand. Even though the need for measures of educational achievement is the same with the blind as with the seeing, the smaller number of blind dictates lesser pressure for such tests to be produced. Furthermore, braille materials are several times more expensive to prepare for publication than print materials and become even more expensive since production must be geared to a limited market. These factors have been obvious deterrants to the interest and the involvement of commercial test publishers in this field.

Objective of the Study

The objective of this study was to construct and standardize a battery of tests for measuring mastery of two braille codes--the Grade 2 literary code and the Nemeth code for mathematical notation. These tests are not tests of reading or mathematics skill as such, but tests of one essential aspect of the ability to read or do number work in braille, *i. e.*, how well the subject knows the elements of the braille codes and the rules governing their use. Because of additional complexities, unique to braille as a code, it is difficult to direct attention to print tests having an analogous purpose. The nearest print counterparts, though measuring a much simpler skill, may be the subtests appearing in the *Gates Reading Diagnostic Tests* entitled "Recognition of Capital Letters" and "Recognition of Lower Case Letters" (Gates 1953).

The eleven tests, comprising the Colorado Braille Battery (CBB), are indicated in Table 1. Seven tests measure knowledge of the Grade 2 literary code and four measure knowledge of the Nemeth code. The literary tests fall into three overlapping levels with two parallel forms at each level. In addition, there is a short "Pretest" designed for screening purposes. The two Nemeth tests fall into two overlapping levels with two parallel forms at each level.

TABLE 1

TESTS COMPRISING THE COLORADO BRAILLE BATTERY

Levels	Braille Literary Code	Nemeth Code (Mathematics)
Pretest: (for screening use)	One Form	———
Beginning Level:	Form A Form B	Form A Form B
Intermediate Level:	Form A Form B	Form A Form B
Advanced Level:	Form A Form B	———

The battery is appropriate for use with both children and adults. The tests can provide teachers of the blind with objective measurement data regarding a student's over-all knowledge of the braille codes as well as provide a means for analyzing strengths and weaknesses in this area of achievement. The tests may be used with seeing individuals, such as braille transcribers, to obtain measures of their braille knowledge. In addition, the battery should be useful as a research tool.

CHAPTER II

BACKGROUND

Many children and adults classified as blind for legal purposes are able to use modified print materials such as large type books. However, when the loss of sight is considerable or complete, the blind individual must be taught to utilize other sensory avenues for the purposes of written communication. To date, the tactile scheme of embossed dots known as braille has been the most effective approach to this problem. The primary purpose of this chapter is to describe the nature and certain characteristics of braille as a scheme for reading and writing. In addition, the status of standardized achievement testing in braille is briefly reviewed.

Braille

The early development of braille is credited to a young blind Frenchman by the name of Louis Braille (1809-1852). He first proposed his code in 1829 and ten years later published a pamphlet completely describing the system. The braille code was subsequently introduced in this country about 1860, although it was 1932 before any official agreement regarding its use was reached.

The braille cell is a pattern of six dots--three dots high and two dots wide. Each of these six dot positions has been assigned an identifying number as follows:

1 ● ● 4
2 ● ● 5
3 ● ● 6

A braille cell combination may consist of some pattern of one, two, three, four, five, or all six dots A total of 63 such dot combinations is possible, and all 63 have been assigned one or more meanings in the braille codes.

When ink print materials, of a literary nature, are transcribed letter by letter into braille, the product is known as "Grade 1 braille." This type of braille is used little in the United States today. By official resolution of the American Association of Instructors of the Blind (AAIB) and of the American Association of Workers for the Blind (AAWB), "Grade 2 braille" became the authorized braille code for literary material in the United States on January 1, 1959. The aims of Grade 2 braille are to reduce the bulk of brailled material and to facilitate more rapid reading of braille. These results are obtained, however, at the cost of increased complexity in the code. In addition to learning the basic symbols for letters, numbers, signs of punctuation, or composition, the user of Grade 2 braille learns about 190 "contractions" (symbols which stand for a word or a combination of letters). These contractions reduce bulk by requiring fewer cells to represent a given word or part of a word than the number of letters in the print counterpart. Several examples of these 190 contractions are shown in Table 2. The details of Grade 2 braille are specified in two publications obtainable from the American Printing House for the Blind (Joint Uniform Braille Committee 1961).

TABLE 2

SELECTED BRAILLE CONTRACTIONS WITH CORRESPONDING PRINT FORMS (GRADE 2 BRAILLE)

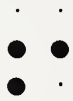
Braille Forms	Print Forms
⠹	th, this
⠮	the
⠬	ing
⠅	k, knowledge
⠰⠑	ence (56 e)
⠐⠹	through (5 th)
⠘⠮	these (45 the)
⠘⠹	those (45 th)
⠁⠇⠹	although (a l th)
⠗⠉⠧⠛	receiving (r c v g)

A further source of complexity in Grade 2 braille is attributable to the variety of formats in which words are written. Five patterns are possible. A word may:

1. be spelled letter by letter
2. utilize special contractions such as "er", "sh", and "ound"
3. consist of a simple abbreviation
4. be a unique form, such as the single cell combinations representing "the", "for", and "with"
5. be some combination of the above.

For any particular word written in Grade 2 braille, only one of these patterns is the correct form. Print words, on the other hand, with rare exceptions, follow only the first of these patterns--they are spelled letter by letter.

Further complexities in the braille literary code are due to assignment of multiple meanings to most of the 63 combinations. For example, the braille reader, or transcriber, learns the combination of dots 2, 3, and 5



has one of three interpretations *depending upon the context*. This particular combination of dots may represent the word "to", it may represent "ff" within a word, or it may represent the exclamation point. In ink print there are three unique symbols, or combinations of symbols, representing these three different meanings. Two examples of this complexity may already have been noted in Table 2 where the braille form corresponding to "th" may also be interpreted as the word "this." Likewise, the braille form for "k" may also be interpreted as the word, "knowledge." Several more illustrations have been provided in Table 3.

TABLE 3

SELECTED SINGLE CELL BRAILLE COMBINATIONS WITH CORRESPONDING MULTIPLE PRINT FORMS (GRADE 2 BRAILLE)

Braille Forms	Print Forms
⠖	to ff !
⠃	b but 2
⠲	dis dd $. (period)
⠶	gg were ( )
⠒	cc con :

A special braille code for use in mathematics has been developed by Abraham Nemeth (APH, 1962). Nemeth is himself blind and originally developed this code for his own personal use. The publication of the code was sponsored by the AAIB and the AAWB to facilitate the transcription of texts and other material in the field of arithmetic and mathematics. The Nemeth code is still in a state of flux and rather significant changes may be made within the next year.

The ten digits are represented in the Nemeth code by the cell combinations for the first ten letters of the alphabet (a to j). However, these combinations are moved from the upper four dot positions into the lower four dot positions of the braille cell. Table 4 illustrates this transposition. When letters are used within a problem, they are written just as they appear in the literary code. In addition, the Nemeth code provides notation schemes necessary to express the various signs of operation and comparison, special alphabets such as Greek, and to indicate spatial relationships within print notation such as exponents, subscripts, and complex equations. This has been accomplished by Nemeth within a system of notation limited to 63 braille cell combinations.

Other braille codes have been developed for various special purposes and proved quite useful. The most notable of these is Louis Braille's code for musical notation (APH, 1956). The history of this code is of particular interest since music was Louis Braille's main interest and the code which he developed has remained almost unchanged.

Braille Tests

Almost without exception, standardized assessment of the reading and arithmetic skills of braille readers is dependent upon tests originally designed for sighted students. The degree of special adaptation for the blind varies from test to test. Some print tests have been simply transcribed into braille with no restandardization or validation of the test in its braille form. Other tests have undergone limited revision and modification, but still lack restandardization and validation.

TABLE 4

COMPARISON OF SEVERAL ALPHABETIC AND NUMERIC CELL COMBINATIONS IN THE NEMETH CODE

Alphabetic Combinations		Numeric Combinations	
⠁	a	⠂	1
⠃	b	⠆	2
⠛	g	⠶	7
⠚	j	⠴	0

Though beset by the limitations mentioned above, standardized tests have been made available in the area of reading for measuring vocabulary, comprehension, speed, and oral reading skills. In the area of arithmetic and mathematics, tests of computation and of problem solving skills have been made available. A further dimension to the objective measurement of reading and mathematics skills in the blind is provided by the Colorado Braille Battery--knowledge of the codes.

Historically, the first standardized testing of the blind was reported by Samuel P. Hayes, in a 1918 study (Hayes, 1918). *The Courtis Silent Reading Test* was given to test the speed and efficiency of blind readers in comparison with sighted. This test required the subject to read for six minutes, making a pencil mark following every half minute interval to indicate the amount read. This process was followed by a series of questions over the material read. As a result of this study it was reported that the reading speed of the blind is less than half as fast as sighted readers. This same study reported experimentation with brailled editions of *Starch's Silent Reading Tests* and with two arithmetic tests, the *Courtis Standard Research Test*, which test fundamental operations in arithmetic, and the *Courtis Test in Arithmetical Reasoning*. The blind were found to be "decidedly inferior" to the sighted on these tests even when allowed to work for periods twice as long. Subsequently, administration of standardized tests to the blind has been modified by allowing the braille reader a testing time two and one-half times longer than allotted on the same test for sighted readers. Several other adaptations in standardized testing procedures have been introduced, such as oral administration of tests customarily read by the subject and by the substitution of multiple-choice questions for matching questions. Such modifications have been introduced in an attempt to make the test situation for the blind more comparable to that for the sighted.

The standardized tests listed below have been transcribed into braille and widely used in measuring educational achievement. Most of these tests incorporate the modifications mentioned above. None have been developed for, or restandardized on, the blind population. Where achievement batteries have been listed below, these batteries contain a subtest in the skill area under which the battery is listed.

Reading Comprehension:

Diagnostic Reading Tests, Survey Section. (Currently available from APHB)

Gates Basic Reading Tests.

Iowa Silent Reading Tests.

Metropolitan Achievement Tests.

Monroe Standardized Silent Reading Tests.

Stanford Achievement Tests. (Currently available from APHB)

STEP (Sequential Test of Educational Progress)

Reading Vocabulary:

Diagnostic Reading Tests, Survey Section. (Currently available from APHB)

Iowa Silent Reading Tests.

Metropolitan Achievement Tests.

Stanford Achievement Tests. (Currently available from APHB)

Reading Speed:

Diagnostic Reading Tests, Survey Section. (Currently available from APHB)

Iowa Silent Reading Tests.

Monroe Standardized Silent Reading Tests.

Oral Reading Skill:

Gilmore's Oral Reading Paragraphs.

Gray's Standardized Oral Reading Paragraphs. (Currently available from APHB)

Arithmetic Computation:

Madden-Peak Arithmetic Computation Test. (Currently available from APHB)

Stanford Achievement Tests. (Currently available from APHB)

Arithmetic Reasoning:

Metropolitan Achievement Tests.

Stanford Achievement Tests. (Currently available from APHB)

Mathematics:

Davis Test of Functional Competence in Mathematics. (Currently available from APHB)

STEP (Sequential Test of Educational Progress)

Since the inception of this project, two tests of braille reading skill have been published in England and a test development project, supported by the Office of Vocational Rehabilitation, has begun in Boston under the direction of Hanley. All three of these developments, as well as the CBB tests, are efforts to provide objective measures of those braille reading skills related to knowledge of the code. The tests published in England are the Lorimer Braille Recognition Test and the Tooze Braille Speed Test. The Lorimer test is a test of the ability to read braille contractions. The test is diagnostic in nature and intended for use with children in the 7 to 13 age range (Lorimer, 1962).

The Tooze test was developed in conjunction with Lorimer's test and is designed to measure the speed with which a child can recognize braille characters (Tooze, 1962). Hanley is developing a diagnostic test designed to provide specific information regarding the nature of errors made by the braille reader. His test is expected to provide useful diagnostic information for the remediation of reading problems (Hanley, 1964).

CHAPTER III

DEVELOPMENT OF THE BATTERY

The procedures followed in developing and standardizing the Colorado Braille Battery were typical of the usual steps taken in constructing and standardizing educational achievement tests. The overall effort was divided into four major phases:

1. Preparation of individual test items
2. Construction and analysis of preliminary forms
3. Construction and analysis of the standardization edition
4. Preparation of manuals and the final report

This chapter describes the work and the results of phase one, phase two, and part of phase three. The standardization of the battery is discussed in Chapter IV.

Preparation of Individual Test Items

Individual test items were prepared by members of the project staff who were familiar with braille. Several teachers from nearby school programs for the blind assisted in the preparation of these items during a series of Saturday work sessions. In addition, a Red Cross volunteer braille transcriber who works extensively with the Nemeth code, participated in the project. Altogether eleven braillists cooperated in writing and editing the original pool of test items.

These braillists were assisted in the actual writing of test items by other personnel competent in test construction and item-writing techniques.

The project staff followed closely the contents of several pertinent publications in the process of preparing the individual test items. The major reference publications used for this purpose were the two manuals and the addendum listed below:

> _English Braille, American Edition--1959_, (Joint Uniform Braille Committee, 1961)
>
> _Addendum to English Braille, American Edition_--1959, (Joint Uniform Braille Committee, 1961)
>
> _Nemeth Code of Braille Mathematics, Revised 1956_, (Joint Uniform Braille Committee, 1962)

In addition to the above references, the project staff made substantial use of two well-known instructional manuals for braille transcribers:

> _Dot Writing_, (Wise, 1960)
>
> _Instruction Manual for Braille Transcribing, Third Edition_, (Dorf and Scharry, 1962)

Some of the material published by the National Braille Club was also utilized.

Early in the project it was necessary to consider which type, or types, of question format to utilize. The final decision was to use a multiple-choice format for all test questions. This decision was based in part upon the same advantages which have underlaid the choice of this format for most standardized achievement tests. Special advantages of the multiple-choice approach, appropriate to this battery, were seen as follows:

> The multiple-choice approach allows a more rapid and therefore more extensive sampling of the braille codes.
>
> Such items measure what one can recognize, which represents a wider field than measuring what can be recalled.
>
> The tests are easy to administer, requiring a minimum of preparation and prior study on the part of the examiner.
>
> The tests are economical time-wise for both examiner and subjects, since a minimum of testing time is required in respect to the amount of coverage provided.
>
> The tests are self-contained. With the exception of a pencil or crayon, no extra material or equipment, such as paper or braille writers, need be provided.
>
> The method of responding is simple and requires a minimum of mechanical effort on the part of the subject.
>
> Scoring is completely objective, therefore highly reliable.
>
> Scoring can be accomplished easily and rapidly by clerks, untrained in braille, using prepared keys.

All test questions were designed to be administered orally. The examiner reads a stimulus statement, *e. g.*, "Mark the *comma*." The subject determines which of the five alternatives presented in the test booklet for that question is the correct braille form and marks his choice in the test booklet. This type of administration procedure reduces the contribution of reading ability as a confounding factor in test performance and also provides an economical utilization of test booklet space, since the majority of items requires only one line each.

Test items for the preliminary form were initially prepared with six or seven alternatives rather than five. Following the item analysis of the "Preliminary Edition," the five best alternatives were selected and edited for each item placed in the "Standardization Edition."

Distracter alternatives were selected on the basis of similarity in braille form or similarity in meaning. Distracters which are similar in form include variations in the cell combination such as reversals, omissions of dots, additions of dots, and position shifts (such as the combination of dots 1-2-4 as an alternative to a correct response of combination 2-3-5). Distracters which are similar in meaning may be illustrated by the item which asks the subject to indicate the "colon." Among the distracters within this item is included the braille form for the "semi-colon." Other items, which include distracters of this second type, require subjects to distinguish between the correct Grade 2 braille form of a word and an incorrect form which would be correct as Grade 1 braille. For example, the correct form for the word "go" in Grade 2 braille is the letter "g." The distracters for this item include the incorrect form "g-o" (spelled as it would be written in print or Grade 1 braille).

Upon completion of this phase of the project, the item pool contained approximately 600 items based upon the literary code and 250 items based upon the Nemeth code. The number of items constituting the pool was made larger than the required number in order to allow the staff to eliminate the poorer items from inclusion in the standardization edition.

Construction and Analysis of Preliminary Forms

During and following the development of the item pool, a series of preliminary tests were assembled, administered, and evaluated. Master copies of the several preliminary tests were prepared on standard braille paper using a Perkins brailler. These masters were duplicated on 11" X 11 1/2" Brailon using the "ThermoForm 55" vacuum forming process.[1]

The final stage in the development of preliminary tests was the preparation and analysis of the "Preliminary Edition." The major objective at this stage was to obtain the item-analysis data required prior to building the Standardization Edition. The Preliminary Edition consisted of the item pool divided into four tests: Beginning Literary; Advanced Literary; Beginning Nemeth; and Advanced Nemeth. These tests were longer than anticipated for the Standardization Edition, thus allowing less effective items to be discarded still retaining an adequate number of items to build a pair of equivalent forms of each test at each level.

The Preliminary Edition was administered to approximately 250 subjects comprising the braille reading students in three residential schools for the blind (Iowa, Nebraska, Oregon) and in the public school programs of the Duluth and St. Paul area of Minnesota. A few braille reading students in the Colorado School for the Blind were administered certain tests. Schools participating in this stage of the study were selected on the basis of convenience and availability.

---

[1] Distributed by the American ThermoForm Corporation, 1732 West Slauson Avenue, Los Angeles 47, California.

Members of the project staff administered all tests with the exception of those tests administered in the Duluth-St. Paul programs. These were administered by classroom teachers under the direction of a project staff member. Table 5 reports the distribution of subjects by grade and test in the Preliminary Edition sample.

The project staff scored, tabulated, and analyzed data from approximately 400 tests. The major objectives of this step were to obtain the item analysis data needed for selecting items to be included in the Standardization Edition and to obtain the subtest reliability information needed to estimate the required length of each subtest in the Standardization Edition.

Item analysis was facilitated by preparing an item data card for each question. These cards included a print copy and a braille copy of the test item. The following data for each grade level of administration was recorded: number of subjects, number of correct responses made by subjects who scored in the upper half in respect to total score on that subtest, number of correct responses made by subjects who scored in the lower half. These data were recorded for each alternative of the item as well as for the item as a whole. Spaces were provided for recording the discrimination index and the difficulty index of the item at each grade level.

Item discrimination indices were estimated by an internal-consistency method utilizing tetrachoric correlation coefficients (r_{tet}). Values were read directly from a nomograph prepared for this purpose by Casebolt and Pace.

TABLE 5

DISTRIBUTION OF SUBJECTS BY TEST AND BY GRADE IN THE PRELIMINARY EDITION SAMPLE

Grade	Beginning Literary	Advanced Literary	Beginning Nemeth	Advanced Nemeth
1	9			
2	22	11	9	
3	33	13	36	
4	25	16		
5		26	20	
6	21	21	28	
7		25	22	10
8		23	17	15
9		18	24	20
10		13		13
11		8		14
12		9		

The use of this nomograph requires knowledge of the percent of students in the lower half who answered the item correctly and the percent of students in the upper half answering the item correctly.[1]

Difficulty indices for each grade level were estimated by calculating the proportion of students at each grade level answering the item correctly. A grade level equivalent was determined for the .50 difficulty level of each item by interpolation between the grade level equivalents of the two bracketing difficulty indices.

Split-half reliabilities were calculated, and the Spearman-Brown formula was used to estimate the ratio of subtest length in the Standardization Edition to subtest length in the Preliminary Edition required for reliabilities of .90 or higher As a result of this analysis, certain proposed subtests were dropped and others were combined into a single broader test or subtest.

Construction of the Standardization Edition

The statistical analysis of the Preliminary Edition provided the necessary information for selecting and editing items for inclusion in the Standardization Edition. Approximately one-half of the items used in the Preliminary Edition were reused in the Standardization Edition.

Preferred items for inclusion in the Standardization Edition were those having a combination of highest discrimination and approximately 50% difficulty within the grade levels for which a test was designed for use. In order to achieve the necessary number of items for two forms of each test, these criteria were reduced successively until the number of desired items had been selected from the pool of available items.

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[1] H. J. Casebolt and W. T. Pace. "Chart for computing tetrachoric r with the criterion dichotomized at the median." North Carolina State Personnel Department, Raleigh, North Carolina.

Selected items were arranged in order of difficulty and assigned alternately to Form A and Form B. Adjustments were made, if needed, to equate the average difficulty levels of the alternate forms. With a few exceptions where the close proximity of two items might provide an unwanted clue to the subjects, all items within each test were placed in order of increasing difficulty.

Following item assignment, each item was edited by dropping the one or two excess alternatives prepared at the time the item was originally written. This editing was guided by the item analysis data available for each distracter. Further editing of the selected items was undertaken if indicated by the item analysis data or the subjective evaluation of the project staff.

The completed Standardization Edition consisted of eleven tests. Seven of these were tests of the literary code and four were tests of the Nemeth Code. The composition of the Standardization Edition is outlined in Table 6.

Two alternate forms of the literary code tests have been provided at each of three levels--"Beginning," "Intermediate," and "Advanced." These three levels overlap sufficiently to allow suitable measurement of subjects who are "between levels." The particular level to be administered should be based upon an estimate of a subject's mastery of braille and not upon his age or school grade placement. For example, an adult blind subject who is in the early

TABLE 6

TESTS COMPRISING THE STANDARDIZATION EDITION

Test	Forms	Number of Items	
Literary Code Tests: (Grade 2 braille)			
Beginning Level	A, B	82	
Letters Subtest			22
Punctuation Subtest (Including signs of composition)			12
Word Form Subtest			48
Intermediate Level	A, B	69	
Punctuation Subtest (Including signs of composition)			21
Word Form Subtest			48
Advanced Level	A, B	48	
Punctuation Subtest (Including signs of composition)			22
Word Form Subtest			36
Pretest (for screening use)	(one)	13	
Nemeth Code Tests: (1956)			
Beginning Level	A, B	34	
Intermediate Level	A, B	30	

stages of learning braille should be administered the "Beginning" literary test, not one of the more advanced levels.

The seventh test of the literary series is called the "Literary Pretest." This test was introduced experimentally into the Standardization Edition. The Pretest is a brief screening instrument designed to determine which of the three levels of the Literary Code Test would be most appropriate for use with a subject when the examiner does not have prior information about the subject's skill in braille. The pretest was prepared by selecting 13 highly discriminating items spaced throughout the difficulty range of literary test items. The easiest item has an average difficulty level of 2.0. Subsequent items increase in average difficulty by increments of approximately 3 months. These items provide a set of highly discriminating items within the range most significant in determining whether a subject should take the Beginning Level, the Intermediate Level, or the Advanced Level Test. Cutting scores, to aid examiners in making these decisions will be determined from a study of the standardization data. There is one form of the Pretest. It can be administered in approximately 5 minutes.

Two alternate forms of the Nemeth Code tests are provided at each of two levels--"Beginning," and "Intermediate." Original plans called for an "Advanced" level Nemeth test. Two factors, however have made it impractical to carry out this portion of the plan. First, the Nemeth code is not yet being used universally for beginning algebra and geometry, and the number of individuals who have studied advanced mathematics using the Nemeth code were too few and scattered to obtain an adequate sample for standardization purposes. The second factor influencing the decision is the forthcoming revision of the Nemeth code. This code, particularly in respect to higher mathematics, probably will be revised during 1964 thus outdating an Advanced Level test quite soon. The majority of elementary students are presently using the 1956 revision of the Nemeth code, thus the Nemeth tests which were developed for this level should be useful for a few years and perhaps may require only minor changes to correspond with a revised Nemeth code.

Instructions for administering the tests were prepared by the staff. The right-hand third of each page in the instruction booklets was left blank. Examiners were requested to make notations regarding errors, comments, or suggestions which occured to them as they studied or administered the tests. The examiners were also requested to indicate the time each test was begun and the time ended

Transparent plastic keys were prepared to facilitate scoring the tests. These keys were punched with a hole corresponding to the location of the correct answer for each test item. Nemeth tests and Pretests were scored entirely by hand. Literary test responses were transferred by clerks onto IBM answer sheets which were subsequently scored by machine.

The standardization edition was embossed by the American Printing House for the Blind. After embossing, the tests were shipped directly to the schools participating in the standardization.

Summary

The construction and standardization of the Colorado Braille Battery followed steps typical for the development of standardized achievement tests. A pool of test items was prepared by several competent braillists. Pertinent references were followed by these item writers as a guide to the content of the item pool.

The initial pool of items was combined into a battery of tests comprising the Preliminary Edition. This battery was administered to the braille readers attending several school programs for the blind. The resulting data was item analyzed to determine discrimination and difficulty indices. Reliabilities were calculated to estimate the length of tests which would be necessary to obtain satisfactory levels of reliability in the Standardization Edition.

Approximately one-half the items used in the Preliminary Edition were reused in the Standardization Edition. The standardization battery contained eleven tests--seven literary code tests, and four Nemeth code tests.

CHAPTER IV

STANDARDIZATION OF THE BATTERY

This chapter reports the procedures followed in standardizing the Colorado Braille Battery and the results of data analysis. The discussion is divided into five major sections which discuss respectively: the standardization sample, the distribution of raw scores, normative procedures, validity, and reliability.

Standardization Sample

The standardization sample consisted of the braille reading students attending 62 randomly selected school programs for the blind in the continental United States. Nineteen of these 62 programs were residential schools for the blind and 43 were public school programs. The public school programs were drawn from a population of programs believed to have ten or more braille readers enrolled. After selection and initial contact, several public school programs were found to have fewer than ten braille readers. Some of these programs were retained in the sample because of an expressed interest in participating in the study. The distribution of programs by size in the standardization sample is shown in Table 7.

The total standardization sample contained 2023 subjects. Residential schools for the blind accounted for 1494 subjects while public school programs accounted for 529. A complete tabulation of subjects by grade level in each of the 62 participating programs has been included in Appendix A.

TABLE 7

DISTRIBUTION OF STANDARDIZATION SAMPLE BY SIZE OF PROGRAM

Size (Number of Braille Readers in sample)	Residential Schools	Public Schools
Less than 10	0	26
10-24	3	12
25-49	5	5
50-99	6	0
100-199	4	
200+	1	

Approximately 10,000 tests were administered to the standardization sample. Table 8 indicates for each grade level the number of subjects to whom the eleven tests were administered. Students above the first grade level were typically administered five tests--two literary tests, the literary pretest and two Nemeth tests. The combination of test forms and levels administered subjects was varied from school to school in order to maximize the data obtainable from the standardization testing. Certain subjects were administered the two forms of a literary or Nemeth test appropriate for their grade placement. Other students at the same grade level took one test appropriate for their grade placement and a second test more appropriate for a lower or a higher level. This latter combination provided the necessary data for determining grade norms.

Raw Score Distributions

Appendix B includes several tables reporting selected percentile values for each test and subtest in the battery. These statistics are reported for each grade level by residential school, by public school and "combined." Percentile values have not been calculated if fewer than 10 subjects took a test at any particular grade level within the residential or the public school sample.

In order to estimate values most typical of the braille reading school population as a whole, the medians and other percentile values reported for the "combined sample" are weighted according to the proportion of braille readers in each type of program in the combined population. The calculation of "weighted percentiles" was accomplished by the following formula:

$$P_{cg} = (P_{rg})\ (k_{rg}) + (P_{pg})\ (k_{pg})$$

where P_{cg} = the weighted percentile for the combined sample at grade level g.

P_{rg} = the percentile obtained for the residential school sample at grade level g.

P_{pg} = the percentile obtained for the public school sample at grade level g.

TABLE 8

DISTRIBUTION OF SUBJECTS BY TEST AND BY GRADE IN THE STANDARDIZATION SAMPLE

Grade	Beginning Literary		Intermediate Literary		Advanced Literary		Pre-test	Beginning Nemeth		Intermediate Nemeth	
	A	B	A	B	A	B		A	B	A	B
1	117	71	36	49			159				
2	91	71	71	58	0	19	169	123	122		
3	104	67	146	139	10	36	265	203	195		
4	44	21	134	150	69	102	276	211	208	2	0
5	17	11	62	35	151	165	232	166	142	19	31
6			42	19	139	162	180	151	98	3	42
7			28	0	100	122	127	75	48	27	58
8			28	8	110	134	149	81	72	36	69
9			3	4	87	91	109	50	25	32	51
10					64	67	82	27	2	40	47
11					51	50	64	21	6	25	41
12					53	54	64	19	0	21	37

k_{rg} = the proportion of residential school braille readers in the combined population at grade level g.

k_{pg} = the proportion of public school braille readers in the combined population at grade level g.

In order to calculate the k_{rg} and k_{pg} values it was necessary to have information regarding the number of braille readers in each type of program at each grade level in the entire population. The data used for this purpose are shown in Table 9.

The use of percentile statistics rather than means and standard deviations to indicate central tendency and spread has been utilized in this report for two reasons. First, the obtained measures of central tendency are subsequently used as reference points for plotting grade norm curves. Since it was necessary for the purpose of determining norms to administer the tests at grade levels substantially above and below the level for which a particular test was designed, considerable truncation of score distributions was anticipated at such levels. Either arithmetic means or medians would be approximately equal at the level for which each test was designed. Medians, however, provide a more typical measure of central tendency at levels with truncated distributions, thus furnishing a more accurate set of reference points in the extremes of the norming range. The second reason for using percentile statistics was the desire to provide meaningful indices of variability of performance. It is believed that a set of percentile values provide information about the distribution of test performance which will be more meaningful to most users of these tests than standard deviations.

TABLE 9

BRAILLE READERS BY GRADE AND TYPE OF PROGRAM (1962-63)*

Grade	Residential Schools	Public Schools	Both
1	587	272	859
2	502	312	814
3	575	394	969
4	524	429	953
5	464	344	808
6	457	270	727
7	344	195	539
8	320	162	482
9	326	138	464
10	277	133	410
11	210	96	306
12	195	87	282
Total (Grades 1-12)	4781	2832	7613

*From Jones, John W. Personal Communication. "Distribution of January 7, 1963 quota registrations by school grades, and braille and large type reading." (2 pp. mimeographed)

Norms

Both grade norms and percentile norms have been prepared for potential users of these tests. All normative data is based upon combined values representative of the entire braille reading population attending residential and public school programs in the continental United States. Users of the tests desiring separate data for residential programs, or for public school programs, may wish to refer to Appendix B of this report.

Grade norms. Grade norms have been prepared for inclusion in the three test manuals. (Copies of these manuals have been placed in this report as Appendix C.) The first step in calculating norms for each test was to plot the weighted median values for each grade upon a chart. A smoothed curve connecting these points was drawn with the aid of a French curve. Norm values were obtained by entering the chart at successive raw score values, extending a horizontal line to the fiftieth percentile curve, dropping a vertical line to the grade scale, then reading the value on the grade scale intercepted by the vertical line.

Percentile norms. Tenth, twenty-fifth, fiftieth, seventy-fifth, and nintieth percentile norms have been determined for selected grade levels. These norms have been provided for each test over the range of appropriate usage for that test. The procedure followed in calculating the several percentile norms was an extension of the procedure for obtaining grade norms. Weighted percentile values were calculated for the combined sample and were plotted as reference points upon the same chart previously used in the determination of grade norms. Smoothed curves were drawn with the aid of a French curve, and the tables prepared in the same manner as described above for the determination of grade norms. The curve already prepared for determining grade norms provided the fiftieth percentile values. Percentile norms are reported in the manuals of Appendix C.

Validity

The validity of a test is defined as the extent to which the test measures what it purports to measure. Attention is directed to the _Technical Recommendations for Psychological Tests and Diagnostic Techniques_, (APA, 1954), for pertinent remarks concerning the types of validity and their evaluation.

Four types of validity are characteristically referred to in the literature These are named "content validity," "predictive validity," "concurrent validity," and "construct validity." These four types of validity are associated respectively with the following four aims of testing:

> 1. The test user wishes to determine how an individual would perform at present in a given universe of situations of which the test situation constitutes a sample.
>
> 2. The test user wishes to predict an individual's future performance (on the test or on some external variable).
>
> 3. The test user wishes to estimate an individual's present status on some variable external to the test.
>
> 4. The test user wishes to infer the degree to which the individual possesses some trait or quality (construct) presumed to be reflected in the test performance.
>
> (APA, 1954, p. 13)

The aim of testing applicable to the Colorado Braille Battery is the first aim described on the preceding page, thus signifying a requirement to demonstrate content validity. The evaluation of content validity is described by a further statement drawn from the APA reference:

> Content validity is evaluated by showing how well the content of the test samples the class of situations or subject matter about which conclusions are to be drawn. Content validity is especially important in the case of achievement and proficiency measures.
>
> In most classes of situations measured by tests, quantitative evidence of content validity is not feasible. However, the test producer should indicate the basis for claiming adequacy of sampling or representativeness of the test content in relation to the universe of items adopted for reference. (APA, 1954, p. 13)

The procedure followed by the project staff in preparing the test items and combining these items into a battery of tests was described in Chapter III of this report. In review, the original pool of test items consisted of two items for each discrete element identified in the code. To insure content accuracy and coverage, a staff of eleven braillists cooperated in writing and editing this pool of items. The project staff followed closely the contents of several pertinent publications. These publications included manuals setting forth the authorized codes and two well-known instructional manuals for braille transcribers.

Reliability

A test is reliable to the extent that repeated measurements give consistent results. Three types of information may be utilized in the evaluation of a test's reliability. These are set forth as follows:

> Reliability is a generic term referring to many types of evidence. The several types of reliability coefficient do not answer the same questions and should be carefully distinguished. We shall refer to a measure based on internal analysis of data obtained on a single trial of a test as a *coefficient of internal consistency*. The most prominent of these are the analysis of variance method (Kuder-Richardson, Hoyt) and the split-half method. A correlation between scores from two forms given at essentially the same time we shall refer to as a *coefficient of equivalence*. The correlation between test and retest, with an intervening period of time, is a *coefficient of stability*. Such a coefficient is also obtained when two forms of the test are given with an intervening period of time. (APA, 1954, p. 28)

Internal consistency. The calculation of internal consistency coefficients was accomplished by use of the Kuder-Richardson 20 formula as modified by Tucker (Guilford, 1953, pp. 382-83; Tucker, 1949):

$$r_{tt} = \left(\frac{n}{n-1}\right)\left(\frac{\sigma_t^2 - M_t + \frac{M_t^2}{n} + n\sigma_p^2}{\sigma_t^2}\right)$$

where n = number of items in test

σ_t^2 = variance of scores on the test

M_t = mean score on the test

σ_p^2 = variance of the proportions of correct responses

The Tucker formula is a simplified version of the KR-20 formula. However the Tucker modification does not make the assumption of equal item difficulty as made by the popular KR-21 formula. The modified KR-20 formula is similar to the KR-21 formula except that a value, based upon the variance of item difficulties, is added to the numerator of the KR-21 formula. The effect is to reduce the underestimation of reliability incurred when the KR-21 formula is used with a test composed of items having varied difficulty levels. The item difficulty indices necessary for these calculations were available from the item analysis data on the Preliminary Edition. Estimates of the variance of item difficulties were calculated by the formula:

$$\sigma_p^2 = \frac{\Sigma p^2}{n} - \left(\frac{\Sigma p}{n}\right)^2$$

Internal consistency coefficients (r_{tt}) and corresponding standard error of measurement (SE_m) data are presented in Table 10. These values were calculated from the portion of the standardization sample at each grade level administered both Form A and Form B of the same test.

Table 11 reports the correlations obtained among the subtest and total test scores of the three levels of the literary code tests. (Correlations reported between any subtest scores and their corresponding total test scores are spuriously high due to the inclusion of the part score in the total score.) These intercorrelations run fairly high suggesting that subtest scores provide little information over and above that provided by the total scores. However, the use of this battery in the field may show that the separate subtests do, in fact, have differential diagnostic value with certain individuals.

Equivalence of forms. Correlations between alternate forms of the tests (r_{AB}) have been reported in Table 10. These reliability coefficients

TABLE 10

COLORADO BRAILLE BATTERY RELIABILITY DATA

Test	Grade	n	r_{tt}*	SE_m*	r_{AB}
Beginning Literary:	1.9	86	.92	1.48	.70
Letters			.68	1.55	.64
Punctuation			.93	2.85	.80
Word Form			.95	3.60	.90
Total					
Letters	2.9	74	.92	1.18	.78
Punctuation			.66	1.82	.74
Word Form			.94	2.26	.91
Total			.94	3.09	.94
Intermediate Literary:					
Punctuation	2.9	54	.76	1.91	.71
Word Form			.92	2.85	.78
Total			.93	3.46	.88
Punctuation	3.9	125	.89	1.62	.72
Word Form			.92	2.41	.84
Total			.94	2.89	.90
Punctuation	4.9	98	.78	1.79	.60
Word Form			.97	2.00	.77
Total			.96	2.76	.82
Advanced Literary:					
Punctuation	4.9	57	.62	2.09	.71
Word Form			.91	2.20	.86
Total			.91	3.06	.87
Punctuation	5.9	143	.80	1.71	.69
Word Form			.91	1.95	.77
Total			.92	2.84	.80
Punctuation	6.9	139	.65	1.90	.70
Word Form			.89	1.91	.84
Total			.86	2.74	.85

Test	Grade	n	r_{tt}*	SE_m*	r_{AB}
Punctuation	7.9	97	.72	2.02	.59
Word Form			.87	1.43	.81
Total			.88	2.56	.88
Literary Pretest:	1.9	159	.81	1.79	
	2.9	169	.66	1.53	
	3.9	265	.75	1.19	
	4.9	276	.83	1.13	
	5.9	232	.82	1.05	
	6.9	180	.80	1.02	
	7.9	127	.64	.90	
	8.9	149	.80	.86	
Beginning Nemeth:	3.9	181	.68	2.47	.73
	4.9	195	.75	2.44	.75
	5.9	120	.82	2.22	.83
	6.9	92	.84	2.24	.86
	7.9	50	.87	2.16	.82
	8.9	50	.78	2.09	.61
	9.9	27	.84	1.88	.93
Intermediate Nemeth:	8.9	28	.86	2.03	.69
	9.9	29	.70	2.32	.58
	10.9	36	.87	2.36	.62
	11.9	22	.80	2.35	.86
	12.9	18	.75	2.37	.65

*Form A Only

TABLE 11

LITERARY TEST INTERCORRELATIONS
(Form A)

	Punctuation Subtest	Word Form Subtest	Total Test
Beginning Literary:			
(Grade 1, n = 114)			
Letters Subtest	.64	.69	.85
Punctuation Subtest		.60	.75
Word Form Subtest			.88
Intermediate Literary:			
(Grade 3, n = 157)			
Punctuation Subtest		.69	.84
Word Form Subtest			.98
Advanced Literary:			
(Grade 5, n = 146)			
Punctuation Subtest		.54	.87
Word Form Subtest			.96

were calculated by the Pearson product-moment Correlation formula.

Stability. No test-retest reliability data is available on the Colorado Braille Battery at this time.

Summary

This chapter has reported the nature of the standardization sample and presented the statistics necessary for using and evaluating the Colorado Braille Battery. The standardization sample contained 2023 subjects, representing the braille reading populations of 19 randomly selected residential schools and 43 randomly selected public schools.

Grade and percentile norms have been prepared and placed in the test manuals for users of the test. The validity of the tests was discussed and arguments regarding content validity were presented. Reliability data of several types was reported.

CHAPTER V

CRITIQUE

Chapter five presents a critique of the Standardization Edition of the Colorado Braille Battery. This critique is based upon a review of the standardization data, experiences of the project staff with the tests, and comments from professional personnel in the field. Included within the critique are several recommendations pertinent to further development of the battery.

Literary Code Tests

Beginning Level. The Beginning Literary tests are most appropriate for use at the first grade level of achievement. They may be used also at the early second grade level, however, the tests tend to be too easy for most second graders by the latter part of that grade. An exception to the above observation is the Punctuation Subtest which is rather difficult even for second graders. The tendency for this subtest to be relatively difficult has been noted also in the Intermediate and in the Advanced level tests.

Intermediate Level. These tests are most appropriate for use at the grade two level. They are suitable also for use with higher achieving first graders. The Intermediate level is somewhat easy for third graders, particularly the better students in a typical third grade class.

Advanced Level. This level appears most appropriate for students achieving at the fourth grade level or higher. It is adequate for third grade use, especially with higher achievers. By the seventh grade, this test has become rather easy, with the exception of the relatively difficult Punctuation Subtest. Student performance on this subtest never becomes as good as might be expected and little improvement is seen in this skill after the fourth grade.

Pretest. The analysis of the Pretest data indicates this test may be used advantageously for the purpose for which it was designed--to determine the most appropriate level of the literary code test which a subject should take when prior information regarding the subject's competency is not known to the examiner. However, the Pretest may also be useful for purposes such as screening a group to determine which subjects require a more thorough measurement of their knowledge of the braille code, or to obtain a quick estimate of a subject's knowledge of the literary code.

Recommendations

The following recommendations are tendered in respect to improving the literary code tests in the advent of a future revision of the battery:

1. The Punctuation Subtest in all three levels should have several easy items added to the "bottom" of the tests to provide better measurement of average and below average achievers.

2. At the Intermediate and Advanced levels, the extension of the tests to include additional subtests of "word division" and "recognition of errors in context" should be considered.

3. Normative values are extrapolated below 1.9 on the Beginning Literary Test and below 4.9 on the Advanced Literary Test. The accumulation of actual normative data below these levels is highly desirable.

4. In view of the wider use suggested above, rename the present Literary Pretest the "Short Form Literary Test."

Nemeth Code Tests

Beginning Level. These tests were most effective as a measuring device between grades four and eight. They were rather difficult for subjects below grade four and tended to be too easy for most subjects by the beginning of grade nine. The tests are appropriate for use at any level if the primary interest is in the subject's knowledge of the Nemeth Code as used in the preparation of arithmetic tests and materials.

Intermediate Nemeth Tests. These tests appear to be most appropriate for students who have had some advanced work in mathematics using the Nemeth Code. There were few such subjects available in the standardization sample thus the norms resulting from this portion of the study are tentative. Furthermore, grade norms are virtually meaningless due to the small change in performance from grade to grade. In fact, students in grades eleven and twelve (1962-63) performed at a lower level on the Nemeth tests than students in grades nine and ten. Percentile norms for grades nine and ten will be of the most value to users of the tests desiring national norms. These tests should be renormed at a national level after more students have studied mathematics using the Nemeth Code.

Recommendations

Since a revised version of the Nemeth Code appears to be forthcoming, it does not seem practical to become involved in further development of the Nemeth tests at this time. After a revised code has been in use for several years, the following recommendations should be considered in the development of a series of revised Nemeth tests:

1. Tests corresponding to the present Beginning and Intermediate levels should be relabeled Intermediate and Advanced, respectively.

2. A new Beginning level should be added to the battery as a downward extension for use in grades two to four.

3. The new Advanced level should include additional items testing knowledge of the Nemeth code in respect to the various branches of mathematics such as calculus. These additional items might be provided in the form of optional subtests.

Concluding Statement

The construction and standardization of the Colorado Braille Battery has provided another dimension to the measurement of reading and mathematics skills in the blind. This dimension cannot be measured by standard print tests which have been transcribed into braille but must be handled by tests especially constructed for the purpose of measuring knowledge of the braille codes. These tests compare favorably with commercially prepared achievement tests in all respects such as sample selection and composition, validity, and reliability. The weaknesses and limitations of standardized tests in general are of course applicable to the Colorado Braille Battery.

The major objective of this study has been achieved--a battery of tests has been developed and standardized which allows the objective measurement of knowledge of the braille codes. The tests should find use with blind children and adults, sighted persons required to have a knowledge of the braille codes, and as a research tool. Several suggestions have been made relative to future revisions or development of the battery. Undoubtedly further suggestions for improvement, and further uses of the tests, will become apparent as professional personnel accumulate experience with the battery in the field.

APPENDIX A

COMPOSITION OF THE STANDARDIZATION SAMPLE

Residential Schools

School	Number of Subjects by Grade												Not Graded	Total
	1	2	3	4	5	6	7	8	9	10	11	12		
1.	15	8	14	9	11	4	7	6	4	2	1	2	0	83
2.	0	1	4	4	2	0	1	1	1	1	1	0	11	27
3.	0	0	0	8	1	2	1	0	0	0	0	0	0	12
4.	2	0	3	1	0	3	0	0	1	1	2	2	0	15
5.	8	6	5	7	10	8	6	5	7	6	3	3	4	78
6.	6	11	9	13	11	3	4	5	7	5	3	3	0	80
7.	26	27	20	13	11	13	10	6	12	4	4	5	0	151
8.	9	12	19	14	10	12	6	14	9	6	6	9	2	128
9.	9	8	14	9	10	7	5	7	6	7	5	8	0	95
10.	0	0	0	0	5	4	4	0	3	0	0	1	1	18
11.	3	2	4	3	4	6	4	5	1	0	1	1	4	38
12.	13	14	12	29	24	13	9	10	0	0	0	0	0	124
13.	8	18	45	39	30	25	26	29	30	16	10	15	3	294
14.	0	0	6	9	6	1	6	5	6	7	5	3	0	54
15.	5	4	4	4	4	3	3	1	3	1	0	1	0	33
16.	9	11	14	25	8	10	2	6	3	6	3	4	0	101
17.	5	7	3	3	3	6	0	6	0	2	0	0	0	35
18.	4	4	5	4	5	4	3	3	4	1	5	1	6	49
19.	8	8	12	3	7	8	9	6	5	3	4	6	0	79
Total	130	141	193	197	162	132	106	115	102	68	53	64	31	1494

COMPOSITION OF THE STANDARDIZATION SAMPLE

Public Schools

School	Number of Subjects by Grade 1	2	3	4	5	6	7	8	9	10	11	12	Not Graded	Total
1.	0	2	2	2	1	0	0	1	0	0	0	0	0	8
2.	0	0	0	0	0	0	1	1	0	1	0	0	0	3
3.	0	0	3	4	1	1	0	2	0	1	0	0	0	12
4.	1	0	3	5	0	4	0	0	0	0	0	0	2	15
5.	0	2	2	2	3	8	3	1	1	5	1	2	0	30
6.	0	3	2	5	1	0	0	0	0	0	0	0	0	11
7.	0	0	1	2	4	1	0	2	2	1	0	0	3	16
8.	0	0	1	1	2	3	0	0	3	0	1	1	0	12
9.	1	0	1	0	2	2	0	0	0	0	0	0	0	6
10.	2	2	4	10	2	6	4	6	1	4	6	0	0	47
11.	0	1	2	2	2	0	0	0	0	0	0	0	0	7
12.	0	0	0	1	0	0	0	0	0	0	0	0	0	1
13.	0	0	0	0	0	0	0	1	0	0	0	0	0	1
14.	0	0	1	0	0	0	0	0	0	0	0	0	0	1
15.	0	1	4	0	1	0	0	1	0	0	0	0	0	7
16.	0	3	3	2	1	0	0	0	0	0	0	0	0	9
17.	1	1	2	3	0	2	0	0	0	0	0	0	0	9
18.	3	1	2	0	6	1	1	2	0	1	0	1	0	18
19.	1	0	1	0	1	1	0	1	0	0	0	0	0	5
20.	3	1	1	2	0	0	0	0	0	0	1	0	0	8
21.	1	1	0	2	1	0	0	1	0	1	0	0	0	7
22.	0	0	1	0	4	0	0	0	0	0	0	0	0	5
23.	0	1	1	0	1	1	1	1	0	0	0	2	0	8
24.	1	1	1	1	1	3	1	0	0	0	0	0	0	8
25.	4	5	3	3	4	1	0	0	0	0	0	0	2	22
26.	4	0	2	1	2	0	0	0	0	0	0	0	0	9
27.	1	0	1	1	4	0	0	0	0	0	0	0	0	7
28.	0	0	0	2	2	0	1	0	0	0	0	0	0	5
29.	1	0	0	0	0	1	1	0	0	0	0	0	0	3
30.	0	0	2	5	3	2	0	0	0	0	0	0	0	12
31.	0	1	1	0	3	3	1	2	2	0	0	1	2	16
32.	1	0	1	0	2	1	0	1	0	0	1	0	0	7
33.	3	2	1	7	5	3	5	4	1	1	2	0	0	34
34.	4	4	8	9	8	4	3	1	1	1	1	0	0	44
35.	0	1	3	2	2	2	0	0	0	1	0	0	0	11

School	Numbers of Subjects by Grade 1	2	3	4	5	6	7	8	9	10	11	12	Not Graded	Total
36.	1	2	2	4	1	2	0	1	0	0	0	0	0	13
37.	1	0	6	1	2	0	0	2	0	0	0	0	0	12
38.	0	0	2	0	1	0	0	0	0	0	1	0	0	4
39.	0	2	9	11	5	2	3	2	1	1	0	0	2	38
40.	0	0	0	2	0	4	0	2	0	0	0	0	0	8
41.	0	1	1	6	3	0	0	0	1	0	0	0	0	12
42.	0	0	0	5	2	0	0	0	0	0	0	0	0	7
43.	1	2	1	2	1	1	0	1	2	0	0	0	0	11
Total	35	40	81	105	86	57	24	36	15	18	14	7	11	529

PARTICIPATING SCHOOLS

Residential Schools

1. Alabama School for the Blind
2. Arizona State School for the Deaf and Blind
3. Florida School for the Deaf and Blind
4. Idaho State School for the Blind
5. Iowa Braille and Sight Saving School
6. Kansas School for the Blind
7. Maryland School for the Blind
8. Michigan School for the Blind
9. Missouri School for the Blind
10. Montana School for Deaf and Blind
11. Nebraska School for Visually Handicapped
12. LaVelle School for the Blind
13. North Carolina State School for Blind and Deaf
14. Oklahoma School for Blind
15. Utah School for the Blind
16. Virginia School for Deaf and Blind
17. Virginia State School
18. Washington School for Blind
19. West Virginia School for Blind

Public Schools

1. Birmingham, Alabama
2. Berkeley, California
3. Chino, California
4. Hawthorne, California
5. Long Beach, California
6. Modesto, California
7. Sacramento, California
8. San Leandro, California
9. Santa Monica, California
10. Temple City, California School Districts
11. Westminister, California
12. Durham, Connecticut
13. Meriden, Connecticut
14. Wilton, Connecticut
15. Norwalk, Connecticut
16. Ft. Lauderdale, Florida
17. Tampa, Florida
18. Wheeling and Mt. Prospect, Illinois
19. East Chicago, Indiana
20. Evansville, Indiana
21. Hammond, Indiana
22. Prairie Village, Kansas
23. Braintree, Massachusetts
24. Medford, Massachusetts
25. Flint Michigan
26. Fraser, Michigan
27. Livonia, Michigan
28. Marysville, Michigan
29. Mt. Pleasant, Michigan
30. Buffalo, New York
31. Newark, New Jersey
32. Charlotte, North Carolina
33. Cincinnati, Ohio
34. Cleveland, Ohio
35. Dayton, Ohio
36. Parma, Ohio
37. Toledo, Ohio
38. Tulsa, Oklahoma
39. Dallas, Texas
40. Fairfax, Virginia
41. Spokane, Washington
42. West Virginia
43. Green Bay, Wisconsin

APPENDIX B

SUMMARY OF STANDARDIZATION DATA

BEGINNING LITERARY: Letters

Grade	Sample	n		P 10		P 25		P 50		P 75		P 90	
		A	B	A	B	A	B	A	B	A	B	A	B
1	Res.	97	55	7.1	6.2	13.6	10.9	18.2	18.2	20.2	20.9	21.2	21.8
	Pub.	18	14	12.3	16.9	18.2	17.7	20.7	20.0	21.6	21.1	22.1	21.8
	Comb.	--	--	8.7	9.6	15.1	13.0	19.0	18.8	20.6	20.9	21.5	21.8
2	Res.	71	50	16.5	15.5	19.5	18.7	20.7	20.3	21.2	21.4	21.6	22.0
	Pub.	20	21	16.0	15.0	17.2	17.1	19.5	20.6	21.0	21.6	21.5	22.2
	Comb.	--	--	16.3	15.3	18.2	17.0	20.2	20.2	21.1	21.5	21.6	22.1

BEGINNING LITERARY: Punctuation

1	Res.	95	54	2.6	1.9	3.6	3.2	5.2	5.8	7.7	7.7	8.8	8.3
	Pub.	19	15	3.4	2.6	5.4	3.2	6.2	6.8	8.1	8.2	10.5	10.8
	Comb.	--	--	2.8	2.1	4.2	3.2	5.6	6.1	7.8	7.8	9.4	9.1
2	Res.	70	50	3.5	2.5	5.7	5.7	7.3	8.2	9.6	10.1	10.8	11.5
	Pub.	20	21	2.5	2.5	4.5	3.3	6.2	5.2	7.5	7.2	9.5	8.8
	Comb.	--	--	3.1	2.5	5.2	4.8	6.9	7.0	8.8	9.0	10.3	10.5

BEGINNING LITERARY: Word Form

1	Res.	98	55	12.3	8.2	18.3	12.4	29.5	23.2	37.8	28.3	43.1	37.3
	Pub.	19	16	13.4	21.2	19.2	23.2	30.2	33.5	36.8	36.0	41.6	37.9
	Comb.	--	--	12.6	12.3	18.6	15.8	29.7	26.4	37.4	30.7	42.6	37.5
2	Res.	70	50	24.5	21.5	38.1	34.3	42.2	40.5	45.0	44.6	46.6	46.0
	Pub.	20	21	23.5	21.6	31.5	24.8	36.5	34.7	42.5	42.2	45.1	45.4
	Comb.	--	--	24.1	21.5	35.6	30.7	40.0	38.3	44.0	43.7	46.0	45.8

BEGINNING LITERARY: Totals

Grade	Sample	n		P_{10}		P_{25}		P_{50}		P_{75}		P_{90}	
		A	B	A	B	A	B	A	B	A	B	A	B
1	Res.	97	54	22.2	17.9	33.1	31.0	49.9	49.0	63.2	57.8	65.8	66.0
	Pub.	18	16	33.3	40.1	47.0	44.0	58.0	58.0	65.0	66.0	64.3	67.9
	Comb.	--	--	25.7	24.9	37.5	35.1	52.4	51.8	63.8	60.4	65.3	66.6
2	Res.	71	50	48.6	45.5	62.8	59.0	69.4	66.5	74.9	75.1	78.3	78.5
	Pub.	19	18	46.1	42.3	56.2	50.0	63.0	59.0	71.6	73.0	73.0	74.7
	Comb.	--	--	47.6	44.3	60.3	55.6	67.0	63.6	73.7	74.3	76.3	77.0

INTERMEDIATE LITERARY: Punctuation

2	Res.	54	42	3.7	5.9	6.4	8.4	9.2	11.0	12.2	14.8	15.3	16.2
	Pub.	17	16	4.4	5.1	7.8	6.5	10.8	9.5	14.7	13.0	15.3	17.2
	Comb.	--	--	4.0	5.6	6.9	7.7	9.8	10.4	13.2	14.1	15.3	16.6
3	Res.	103	101	8.6	8.5	11.8	11.2	13.9	14.8	16.3	16.8	18.0	18.7
	Pub.	43	37	6.6	7.4	10.6	8.9	13.3	11.3	16.5	15.5	17.8	18.6
	Comb.	--	--	7.8	8.0	11.3	10.2	13.6	13.4	16.4	16.3	18.0	18.7
4	Res.	79	86	10.5	11.2	12.8	13.8	16.4	16.2	17.0	17.2	18.3	18.6
	Pub.	55	55	8.7	10.3	11.0	13.2	14.8	15.2	17.2	17.4	18.4	19.0
	Comb.	--	--	9.7	10.8	12.0	13.6	15.7	15.8	17.1	17.3	18.3	18.8

INTERMEDIATE LITERARY: Word Form

2	Res.	54	42	13.9	13.6	18.0	18.0	24.0	32.0	33.0	36.0	38.1	41.3
	Pub.	17	16	24.2	18.8	26.8	22.5	32.0	28.0	35.8	32.0	46.8	42.9
	Comb.	--	--	17.8	15.6	21.4	19.7	27.1	30.5	34.0	34.5	41.4	41.9
3	Res.	102	101	22.7	24.6	31.9	30.8	38.9	38.4	43.4	42.8	45.8	44.4
	Pub.	42	38	21.7	17.3	31.0	28.8	37.0	35.0	43.0	40.2	46.0	44.7
	Comb.	--	--	22.3	21.6	31.5	30.0	38.1	37.0	43.2	41.7	45.9	44.5
4	Res.	78	97	31.9	28.2	37.2	36.8	41.7	41.6	44.6	44.6	46.5	45.5
	Pub.	54	51	31.1	30.6	36.0	36.8	40.8	40.3	45.0	43.8	46.2	46.4
	Comb.	--	--	31.5	29.3	36.7	36.8	41.3	41.0	44.8	44.2	46.4	46.0

INTERMEDIATE LITERARY: Totals

Grade	Sample	n		P10		P25		P50		P75		P90	
		A	B	A	B	A	B	A	B	A	B	A	B
2	Res.	55	39	19.2	19.0	25.1	25.7	34.3	41.0	46.2	50.8	55.7	58.2
	Pub.	16	16	29.1	25.1	35.5	31.5	44.0	37.0	50.8	46.2	56.3	54.9
	Comb.	--	--	23.0	21.3	29.1	27.9	38.0	39.5	48.0	49.0	55.9	56.9
3	Res.	103	101	35.7	35.2	44.2	42.1	51.9	52.6	58.2	58.8	62.0	62.9
	Pub.	43	37	37.6	25.8	41.2	38.8	51.5	46.3	58.1	55.4	62.2	61.2
	Comb.	--	--	36.5	31.4	43.0	40.7	51.7	50.0	58.1	57.4	62.3	62.2
4	Res.	76	95	42.1	45.0	50.7	52.8	57.1	58.6	60.6	62.2	63.6	64.2
	Pub.	55	55	42.7	42.7	48.2	48.8	52.8	55.2	60.1	60.6	64.2	65.1
	Comb.	--	--	42.4	44.0	49.8	51.0	55.2	57.1	60.5	61.5	63.9	64.6

ADVANCED LITERARY: Punctuation

Grade	Sample	n		P10		P25		P50		P75		P90	
		A	B	A	B	A	B	A	B	A	B	A	B
4	Res.	46	72	7.1	8.5	9.4	10.3	11.8	13.5	13.4	16.9	16.3	19.3
	Pub.	23	30	6.9	6.5	8.1	8.1	11.0	11.7	13.6	16.8	15.4	17.5
	Comb.	--	--	7.0	7.6	8.8	9.3	11.4	12.7	13.5	16.8	15.9	18.5
5	Res.	113	131	7.5	9.5	9.8	11.8	12.4	15.2	15.0	17.7	17.4	20.6
	Pub.	36	34	6.3	8.2	9.0	12.0	12.9	15.5	14.8	16.8	17.6	19.8
	Comb.	--	--	7.0	9.0	9.4	11.9	12.6	15.3	14.9	17.3	17.5	20.3
6	Res.	104	128	8.7	10.9	10.9	13.3	13.1	16.0	15.6	18.0	17.2	19.4
	Pub.	35	34	7.8	7.9	9.0	12.0	11.8	14.0	13.9	16.4	14.9	19.1
	Comb.	--	--	8.4	9.8	10.2	12.8	12.6	15.3	14.9	17.4	16.3	19.3
7	Res.	79	104	9.3	12.0	11.6	14.2	14.2	16.6	17.3	19.2	19.3	20.8
	Pub.	21	18	9.5	8.8	10.6	12.0	12.9	15.5	14.2	17.7	16.4	18.7
	Comb.	--	--	9.4	10.8	11.2	13.4	13.8	16.2	16.2	18.6	18.2	20.0
8	Res.	83	107	10.3	12.4	12.3	15.2	13.6	17.4	15.7	19.5	18.3	20.7
	Pub.	27	27	8.2	9.2	11.8	13.7	14.7	15.8	16.2	19.0	20.2	20.2
	Comb.	--	--	9.6	11.3	12.1	14.7	13.9	16.9	15.8	19.4	18.9	20.5

ADVANCED LITERARY: Word Form

Grade	Sample	n		P 10		P 25		P 50		P 75		P 90	
		A	B	A	B	A	B	A	B	A	B	A	B
4	Res.	45	74	14.0	21.9	22.6	25.7	26.2	28.7	31.2	31.6	34.0	33.2
	Pub.	23	28	16.8	15.3	17.7	19.5	21.5	26,5	26.8	29.8	31.8	32.6
	Comb.	--	--	15.3	18.9	20.4	22.9	24.1	27.7	29.2	30.8	33.0	32.9
5	Res.	114	131	18.7	20.6	25.1	27.6	28.8	31.6	32.9	33.9	34.7	35.0
	Pub.	37	34	14.8	12.9	22.8	23.2	29.0	27.8	32.4	33.0	35.2	35.7
	Comb.	--	--	17.1	17.3	24.1	25.8	28.9	30.0	32.7	33.5	34.9	35.3
6	Res.	104	127	22.3	24.6	27.0	29.7	30.0	32.1	33.2	34.1	34.6	35.0
	Pub.	35	35	14.0	16.0	23.2	26.2	27.9	29.8	30.8	32.2	33.8	34.0
	Comb.	--	--	19.2	21.4	25.6	28.4	29.2	31.2	32.3	33.4	34.3	34.7
7	Res.	79	100	25.1	27.2	29.2	30.0	31.4	33.1	35.0	33.9	35.8	35.9
	Pub.	21	18	24.6	26.3	27.8	27.8	32.0	32.0	33.9	33.8	35.0	35.9
	Comb.	--	--	24.9	26.9	28.7	29.2	31.6	32.7	34.6	33.9	35.5	35.9
8	Res.	80	104	27.1	28.6	30.1	31.8	32.8	33.8	34.8	35.0	35.8	35.6
	Pub.	26	27	19.1	22.2	29.0	28.7	32.5	32.2	34.1	34.6	35.1	35.6
	Comb.	--	--	24.4	26.5	29.7	30.7	32.7	33.3	34.6	34.9	35.6	35.6

ADVANCED LITERARY: Totals

Grade	Sample	n		P 10		P 25		P 50		P 75		P 90	
		A	B	A	B	A	B	A	B	A	B	A	B
4	Res.	45	71	25.8	28.6	31.2	35.9	37.2	41.0	44.2	46.9	48.0	51.4
	Pub.	20	29	23.5	24.0	26.8	27.1	29.5	38.8	36.0	42.9	46.5	49.6
	Comb.	--	--	24.7	26.5	29.3	31.9	33.8	40.0	40.5	45.1	47.3	50.6
5	Res.	112	130	28.7	32.8	32.7	39.6	40.5	46.7	48.2	51.0	51.8	54.0
	Pub.	36	34	23.8	20.9	33.0	34.2	42.2	43.0	47.8	49.0	52.9	55.1
	Comb.	--	--	26.6	27.8	32.8	31.6	41.2	45.1	48.0	50.2	52.2	54.5
6	Res.	100	128	32.8	36.4	38.3	43.1	43.0	48.1	47.2	51.3	51.8	53.5
	Pub.	29	34	23.1	23.9	33.8	38.8	37.8	45.0	42.2	47.4	48.6	51.3
	Comb.	--	--	29.2	31.8	36.6	41.5	41.0	47.0	45.4	49.9	50.6	52.7
7	Res.	80	100	35.5	40.0	40.8	44.5	47.2	50.5	51.9	54.0	54.3	55.9
	Pub.	18	18	35.3	35.3	38.6	41.8	42.5	47.0	47.8	51.8	49.7	53.6
	Comb.	--	--	35.4	38.3	40.0	43.5	45.5	49.2	50.4	53.2	52.6	55.1

ADVANCED LITERARY: *Totals* (Continued)

Grade	Sample	n		P_{10}		P_{25}		P_{50}		P_{75}		P_{90}	
		A	B	A	B	A	B	A	B	A	B	A	B
8	Res.	81	106	38.6	42.0	42.2	46.9	48.1	51.2	50.6	54.0	52.5	55.7
	Pub.	24	27	36.9	36.2	43.5	40.2	48.5	48.7	50.5	52.8	53.1	56.9
	Comb.	--	--	38.0	40.1	42.6	44.6	48.2	50.4	50.6	53.6	52.7	56.1

PRETEST LITERARY

Grade	Sample	n	P_{25}	P_{50}	P_{75}
1	Res.	119	4.0	5.8	7.8
	Pub.				
	Comb.	---			
2	Res.	129	5.3	7.3	9.3
	Pub.	40	5.7	7.5	9.7
	Comb.	---	5.4	7.4	9.4
3	Res.	184	7.9	9.7	11.5
	Pub.	83	7.5	9.6	11.7
	Comb	---	7.7	9.7	11.6
4	Res.	174	8.7	10.7	12.2
	Pub.	98	8.6	10.8	12.0
	Comb.	---	8.6	10.7	12.0
5	Res.	147	9.8	11.5	12.3
	Pub.	86	9.4	11.1	12.5
	Comb.	---	9.6	11.3	12.4

BEGINNING NEMETH

Grade	Sample	n		P_{10}		P_{25}		P_{50}		P_{75}		P_{90}	
		A	B	A	B	A	B	A	B	A	B	A	B
4	Res.	113	110	11.2	13.5	14.7	16.2	17.3	19.2	19.2	22.8	22.8	25.9
	Pub.	98	98	11.6	12.2	13.3	16.0	17.5	19.2	20.4	22.6	23.9	25.9
	Comb.	--	--	11.4	12.9	14.0	16.1	17.4	19.2	19.7	22.7	23.3	25.9

BEGINNING NEMETH (Continued)

Grade	Sample	n		P10		P25		P50		P75		P90	
		A	B	A	B	A	B	A	B	A	B	A	B
5	Res.	92	64	11.7	15.0	16.0	18.9	20.0	22.1	24.3	24.3	27.0	28.7
	Pub.	74	79	12.9	15.4	16.2	18.8	20.1	22.3	23.1	26.6	26.1	29.2
	Comb.	--	--	12.2	15.2	16.1	18.9	20.0	22.2	23.8	25.3	26.6	28.9
6	Res.	101	48	15.0	15.1	18.2	20.8	21.9	23.5	25.5	26.2	28.6	28.0
	Pub.	50	50	10.5	11.5	18.4	20.3	21.8	24.6	24.3	26.6	28.5	30.8
	Comb.	--	--	13.3	13.8	18.3	20.6	21 9	23.9	25.0	26.4	28.6	29.1
7	Res.	66	40	16.8	18.5	20.4	21.5	24.7	24.2	28.3	27.3	30.0	29.5
	Pub.	9	8										
	Comb.	--	--										
8	Res.	63	55	18.1	19.8	22.8	23.8	25.9	26.9	29.0	29 6	31.1	31.9
	Pub.	18	17	14.3	17.2	18.0	22.6	27.5	27.2	31.3	32.9	32.9	33.9
	Comb.	--	--	16.8	18.9	21.2	23.4	26.4	27.0	29.8	30.7	31.7	32.9
INTERMEDIATE NEMETH													
8	Res.	23	54	7.8	7.3	10.9	9.7	12.8	13.7	14.2	16.1	17.1	17.9
	Pub.	13	15	4.8	5.0	8.1	7.4	10.2	8.9	18.2	11.2	23.2	21.0
	Comb.	--	--	6.8	6.5	10.0	8.9	11.9	12.1	15.6	14.5	19.1	18.9
9	Res.	27	45	7.4	9.1	9.9	10.6	12.1	13.2	15.6	16.8	18.2	20.7
	Pub.	5	6										
	Comb.	--	--										
10	Res.	17	35	8.2	9.0	12.6	10.3	15.6	14.2	17.2	16.9	24.8	20.0
	Pub.	13	12	7.6	7.6	8.2	8.5	11.8	11.2	20.2	14.5	26.4	20.3
	Comb.	--	--	8.0	8.6	11.2	9.7	14.4	13.2	18.2	16.1	25.3	20.1
11	Res.	15	32	7.0	7.7	8.9	11.0	12.0	12.8	15.8	15.5	22.0	20.3
	Pub.	10	9	12.5		13.2		14.5		17.0		21.5	
	Comb.	--	--	8.7		10.2		12.8		16.1		21.8	
12	Res.	16	34	8.1	7.2	11.5	9.2	12.8	12.3	14.0	15.9	20.2	18.2
	Pub.	5	3										
	Comb.	--	--										

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